Articles

Immunopathologic Effects of Silicone Breast Implants

SUZANNE S. TEUBER, MD; STEVEN H. YOSHIDA, PhD; *and* M. ERIC GERSHWIN, MD, *Davis, California*

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Silicone-gel breast implants have been associated with a myriad of autoimmune and connective tissue disorders by anecdotal reports and small observational series. To date, no prospective epidemiologic studies have been done to substantiate these observations, but an increasing body of literature is being developed and older studies are being recognized that point to immunotoxic or inflammatory effects of these breast implant components. The development of disease due to implants would depend on the interaction of genetic host factors so that only a few patients would potentially be at risk. Based on the example of other chemically mediated disorders, such as scleroderma in association with silica exposure, latency periods of more than 30 years before disease develops may be possible. Herein we review studies on silicone and immunity.

(Teuber SS, Yoshida SH, Gershwin ME: Immunopathologic effects of silicone breast implants. West J Med 1995; 162:418-425)

Silicone-gel implants for breast augmentation and reconstruction have been in use since 1962.[1] Local complications have long been known to occur, primarily consisting of capsular contracture,[2-5] which is a hardening of the implant to palpation due to contracture of the fibrous capsule that normally forms (to varying degrees of thickness) around the implanted foreign body.[2-7] In two series, noticeable capsular contracture developed in as much as 40% to 50% of patients.[3,4] Ruptures can occur either intracapsularly or with extracapsular extension and spread of the gel to the chest wall or axilla. The exact incidence is not known. Virtually all implants have been shown to "bleed" silicone into the local microenvironment,[6] which can be reflected in histologic findings of foreign-body granulomas in the capsular tissues or regional lymph nodes.[7-9] More recent observations using magnetic resonance spectroscopy have demonstrated silicon compounds in the blood of some women with silicone breast implants, as well as evidence of silicone migrating to the liver.[10]

The controversy over the safety of silicone-gel implants has focused not on local complications but rather on the postulated link between the implanted gel and systemic illnesses or symptoms. Well-publicized anecdotal reports have raised concerns, especially in regard to scleroderma, but no prospective clinical series that clearly supports a link between connective tissue disease and implants as yet exists. Because of the lack of studies actually proving the safety of implants, the United States Food and Drug Administration, in its 1992 review of medical devices, decided that the implants should be removed from the market except for use in surgical reconstruction as part of clinical trials.[11] This has spurred research on the bioreactivity of silicone and of clinical observations of patients with implants. Herein we review the chemical properties of silicone implants and bench research studies pointing to adverse immune effects.

Chemistry of Silicone

Silicon constitutes about 28% of the earth's crust by weight.[12] It is an important trace mineral in bone formation and mineralization.[12] Silicon is also associated with glycosaminoglycans, unbranched polysaccharide chains that covalently attach to core proteins to form proteoglycans, which are components of the connective tissue matrix.[13] Silicones are a family of synthetic polymers using silicon-oxygen chains with organic side groups. The silicones used in a multitude of medical products are heterogeneous with respect to polymer lengths, side-chain substitutions, and fillers used. Thus, great variation exists in the biologic and physical properties of these chemicals.

Many persons have had exposure to silicones in some form such as in simethicone (an antifoaming agent in antacids) or possibly in microscopic amounts in injec-

From the Division of Rheumatology, Allergy, and Clinical Immunology, University of California, Davis, School of Medicine, and the Department of Veterans Affairs Northern California System of Clinics (Dr Teuber), Pleasant Hill, California.

Reprint requests to M. Eric Gershwin, MD, Division of Rheumatology, Allergy, and Clinical Immunology, TB 192, University of California, Davis, School of Medicine, Davis, CA 95616.

ABBREVIATIONS USED IN TEXT

ANA = antinuclear antibody
BSA = bovine serum albumin
CFA = complete Freund's adjuvant
Ig = immunoglobulin
PDMS = polydimethylsiloxane

tions where silicone oil is used to lubricate the syringe (such as for insulin), but it must be emphasized that the chemical properties of each product are unique. Figure 1 illustrates the synthetic process.[14,15] First, elemental silicon is produced by heating silica (SiO_2) with carbon. Silicon is then reacted with methyl chloride (CH_3Cl), followed by hydrolysis, which results in the formation of linear or cyclic low-molecular-weight siloxanes. Silanoate catalysts are added that break open the most prevalent siloxane, octamethylcyclotetrasiloxane, to form high-molecular-weight polydimethylsiloxane (PDMS) linear polymers, the silicone used in silicone-gel implants. The gel material is formed by controlling chain lengths and cross-linking to produce a desired viscosity. Platinum and hydride-containing polymers may also be added to the gel.[16] Within the cross-linked PDMS polymer matrix, lower-chain-length PDMS (less viscous oil) is still present.

The outer silicone rubber envelope is a dispersion of silicone elastomer wherein fumed silica (amorphous or particulate, 10 to 15 μm) is compounded with the PDMS polymer to act as a filler or a strengthening agent.[14,15] Hexamethyldisilazane, divinyltetramethyldisilazane, and cyclic or short linear siloxanes are some of the materials that can be used to treat the silica to favorably alter its chemical interactions with the PDMS polymers.[15,16]

Exposure to Implant Components

Local Exposure

Implants were previously thought to be inert, and after an initial mild, nonspecific foreign-body reaction to "seal off" the implant from the rest of the body by a thin collagenous layer, there would be no further interaction such as biodegradation or adherence to tissues.[17] In studies of implants removed because of capsular contracture, it has been shown that the surface of an implant becomes coated with albumin, fibronectin, transferrin, and other proteins, as well as with fibroblasts and macrophages.[18] The affinity of fibronectin for the surface of an unused, sterile, smooth silicone envelope was also investigated in which pieces were incubated in normal human serum or saline solution, and, after washing, a high amount of fibronectin was shown to be adhering to the surface.[18] Fibronectin is an important component of the extracellular matrix allowing cellular adherence and migration.

In 1978 Barker and colleagues conclusively showed that silicone-gel implants do "bleed" silicone gel through the implant shell.[6] Filter papers on which various brands and types of implants had been sitting for a week were sent to Dow Corning (Midland, Michigan) scientists for analysis. They reported that the "distribution, by molecular weight, of the leaked material corresponded to relative quantities of each gel species present inside the envelopes and was not shifted to the lower molecular weights."[6(p836)] This finding is of possible relevance because many of the initial studies in animals showing minimal tissue reaction to silicones used low-molecular-weight silicone oils, whereas later studies, to be discussed, showed more reactivity to the higher-molecular-weight gel species. Gel bleeding follows the principle that "like dissolves like"—that is, the gel and the envelope are manufactured from the same materials, and therefore the envelope is not impermeable to its contents. In a similar manner, hydrophobic human constituents such as triglycerides and other lipids can diffuse into prostheses.[19,20]

Numerous reports document the presence of periprosthetic silicone particles[21] shed from intact implant surfaces or, more commonly, amorphous refrac-

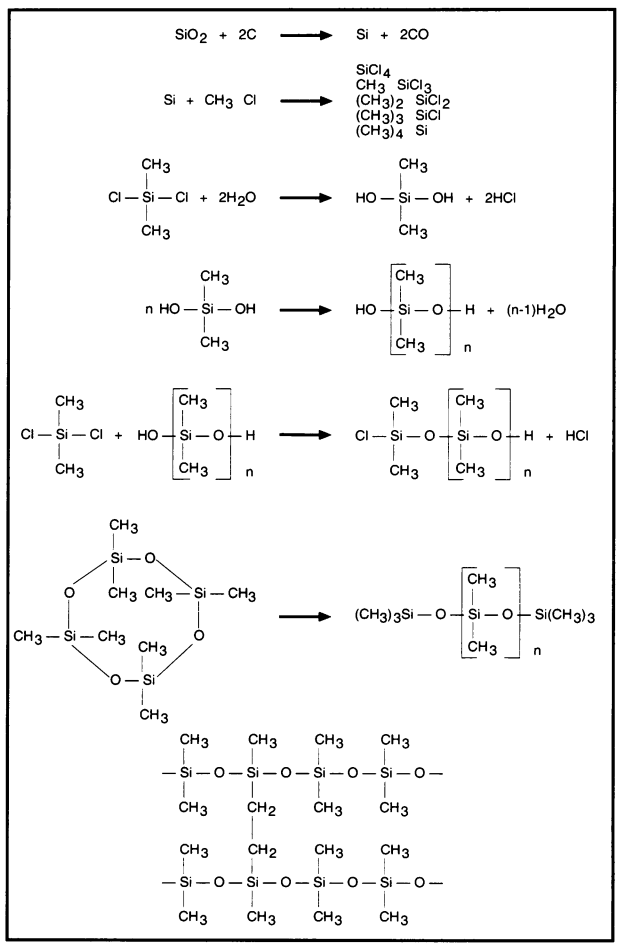

Figure 1.—The diagram shows an overview of polydimethylsiloxane (PDMS) synthesis. This includes, first, the production of elemental silicon (Si). Second, methyl chloride (CH_3Cl) treatment of silicone is used to produce methylchlorosilanes. Thereafter, prepolymers are formed and, ultimately, high-molecular-weight PDMS from cyclic prepolymers. "Curing" occurs using cross-linking agents such as peroxides.

tile material (either intracellular or extracellular) and foamy histiocytes with vacuoles—presumed to represent silicone oils that were removed by xylene used in histologic slide processing.[2,3,22,23] Studies have also documented the high content of silicon in these tissues, affirming that the materials seen are likely silicones.[23-26] Periimplant silicone has been found in both tissues with little or no visible inflammation and those capsule tissues with extreme fibrosis, mononuclear cell infiltrates, granulomas, and calcification.[26] It is hypothesized that the uptake of silicone by macrophages results in cellular activation and the secretion of inflammatory mediators,[27-30] resulting in chronic inflammation, the proliferation of fibroblasts, and collagen deposition around the implant. A recent study showed immunoreactivity in implant capsules for tumor growth factor β, insulin-like growth factors I and II, and some reactivity for platelet-derived growth factor β, nerve growth factor, and tumor necrosis factor-α. Mature skin scar tissue did not show any immunoreactivity for these growth factors.[31] It has also been proposed that low-grade bacterial contamination of the implant surface, rather than the body's reaction to silicone, may account for chronic inflammation in some cases.[32]

Silicone gel-filled implants account for the vast majority of implants that have been used. Saline implants pose the same exposure to the body of the components of the outer silicone rubber envelope. Polyurethane-coated gel-filled implants pose another exposure variable that will not be addressed in this review. These implants were removed from the market in 1991 when concern arose that the polyurethane foam can be degraded to constituents that include toluene 2,4-diisocyanate, a carcinogen in rats.[33] The polyurethane foam coating has been noted to separate from the implant and slowly degrade, provoking a foreign-body inflammatory response much like the response to silicone alone.[34]

Distant Exposure to Implant Components

Studies in animals done in the 1960s with small volumes of liquid silicone administered either subcutaneously or intraperitoneally in mice resulted in mild inflammation and fibrosis at the site of many of the subcutaneous injections and occasional collections of silicone-laden cells in the zona reticularis of the adrenal glands. Massive doses resulted in widespread visceral collections of vacuolated cells in lymph nodes, liver, kidneys, spleen, pancreas, adrenal glands, and ovaries.[35,36] Vacuoles, presumed to represent silicone fluid, were seen for several weeks in the peripheral blood neutrophils and some monocytes of mice and baboons after the subcutaneous or intraperitoneal administration of silicone fluid.[37]

It is evident also from human case reports that silicone droplets that bleed from an implant or shed elastomer particles from the outer implant shell do indeed undergo phagocytosis by macrophages and transport to distant organs. The most commonly reported involvement is of the axillary lymph nodes.[8,9] Silver and coworkers recently demonstrated silicon-containing material by electron-probe microanalysis in the skin, alveolar macrophages, and synovia of three patients with implants and connective tissue disorders.[38] Experience with migrated liquid silicone administered in humans—in which silicone has been found in alveolar macrophages associated with pneumonitis and in liver parenchyma with granulomatous changes—can be extrapolated to gel implants, but inadvertent intravenous or intra-arterial administration remains a possibility.[39,40] Shed silicone particles from dialysis tubing were reported to be the cause of granulomatous splenomegaly (with foreign-body reaction) in one patient suffering from splenomegaly-associated pancytopenia.[41]

Gel bleeding can explain the exposure of virtually all patients to at least microscopic quantities of silicone, but it should be kept in mind that implants do have a finite life span, and rupture, which may be contained by the capsular tissue or which may also involve the capsule, is probably inevitable. The actual incidence of implant rupture is not known.

Silicone could migrate away from the site of the breasts by several mechanisms: migration of silicone collections along fascial planes, probably influenced by gravity and muscle action[42]; uptake by macrophages that may enter lymphatic channels or the bloodstream[8,9]; release from dying macrophages with possible uptake by macrophages or other phagocytic cells, depending on site[37,43]; transfer from macrophage to lymphocyte by cytoplasmic bridging[44]; and the formation of emulsions with host molecules and subsequent dispersal.[45]

Biodegradation of Implant Materials

A point to keep in mind is that biodegradation products of silicone implants, or even chemical contaminants, may be more mobile and more important than an implant's original and primary constituents in any eventual manifestation of disease. Hydrolytic degradation may slowly affect lightly cross-linked polymers.[46] Silicones may be degraded by oxidants such as hydroxyl radicals that can cleave silicon carbide bonds. When exposed to water, silanol bonds could form that could result in new siloxane chain linkages. In addition, although silicones were reported to be resistant to acids and bases, under certain conditions, they may be susceptible to cleavage (C. W. Lenzt, "It's Safe to Use Silicone Products in the Environment," Dow Corning Chemical Corporation, Industrial Research Development, April 1980). A study on silicone bag-gel implants in dogs showed changes in mechanical properties after a year.[44] Anecdotally, in the operative report of one of our patients seen in the University of California, Davis, Rheumatology Clinic, the surgeon reported that the implant shell was no longer present at the time of explantation.

An internal Dow Corning report provides some of the first data on the biodegradation of organosilicones in humans. In 1980 a male volunteer inhaled about 20 mg of the DC-344 fluid; measurements suggested that near-

ly 20% of the estimated quantity of DC-344 fluid was excreted in the urine in the eight hours following exposure. The presence of monomethyl as well as dimethyl silicon in the urine implicated demethylation of the cyclic dimethyl species during human metabolism. Of greater concern is the presence of metabolites in the breast milk of a lactating woman who was exposed by inhalation (R. B. Annelin, "Trace Analysis of Organosilicon in Human Urine and Milk by the ASFT Technique," Dow Corning Toxicology Department File No. 3135-1, Series No. 1-0005-0752, 1980; and the Jefferson Group, Inc, "A Review of the Toxicological Information on Octamethylcyclotetrasiloxane and Related Government Action," Dow Corning Corp, 1992, pp 28402115-28402143).

The strongest data in the literature for biodegradation in vivo come from a series of articles detailing findings in a rat model by nuclear magnetic resonance spectroscopy.[10,47-50] These studies demonstrate the migration of silicones from both subcutaneous administration of a polysiloxane emulsion and from bag-gel implants to the lymph nodes and liver at 12 months. An interesting point is that there were shifts in the resonance peaks to those corresponding with hydrolyzed silicone and with silica. Neither of these resonances was present in the silicones before implantation, suggesting in vivo degradation.

Inflammatory and Immune Responses to Implants and Components

Local Tissue Response

In the most thorough investigation on tissue responses to various implant components,[16] rats were implanted subcutaneously with fumed silica, silicone gel, silicone fluid, silica-free implant shell, implant shell ("as manufactured"), xylene-extracted implant shell ("implant-ready"), and the evaporated xylene extract (possibly containing residual macrocyclics or platinum catalyst, but unknown). Rats were sampled at days 7, 14, 30, 60, and 90. All components showed inflammation to varying degrees, but the most intense inflammatory response was towards the fumed silica, with fibroblasts, lymphocytes, macrophages, plasma cells, and multinucleated giant cells. Cellular destruction was also evident with the fumed silica, reminiscent of what is seen with crystalline silica.[51,52] The silica-free shell was somewhat less reactive than the "implant-ready" extracted shell and showed less collagen capsule formation, which could possibly be attributed to mechanical factors (increased compliance). Although the authors of these studies do not propose that silica is released from implant shells, nuclear magnetic resonance studies done later make this a tenable hypothesis and may account for the differences seen.[47-50] The implant shell extract, which would not be expected to contain silica, had the greatest number of multinucleated giant cells. Amorphous silica has not been associated with pulmonary silicosis or scleroderma, unlike crystalline silica,[53,54] but it has not been as extensively studied.[55,56]

Tissue response to accidentally introduced siliceous material in the skin from concrete or rock can induce local silica granulomas that can mimic sarcoidosis. It has been proposed that many cases of sarcoid arising in scars are actually silica granulomas.[57,58] A series of 41 patients was recently published wherein the periprosthetic tissues were examined for magnesium silicate, which was hypothesized to be talc ($MgSi_4O_{10}[OH]_2$).[59] Of these 41 patients, 29 (71%) did have birefringent crystals in granulomas or in perivascular histiocytes. Silicone aggregates were not birefringent. Of the capsules, 70% showed free silicone, but 100% of the tissues did have empty cysts and vacuoles after xylene processing, suggesting dissolution of silicone before scanning electron microscopy. The presence of magnesium silicate and silicone was confirmed by scanning electron microscopy with energy-dispersive x-ray microanalysis. This is the first report of possible talc granulomas associated with breast implants. Talc is a known sclerosing agent[60] and is associated with granulomatous inflammation.[61,62] It also may have adjuvant properties in animal models.[60,63] The source of magnesium silicate in these patients is unknown; it may have been introduced on surgeons' gloves, on the implants, bled from the implant, or formed de novo as a degradation product. This is an area sure to receive more attention as further histologic studies are done.

Cellular Immune Response

In another internal Dow Corning report, the endotoxin-induced interferon type I production in mice was examined after pretreatment with various silicones. Dow Corning 360 fluid (DC-360, medical-grade silicone fluid used for administration in humans), mixed 1:1 with octamethylcyclotetrasiloxane (D4) in a volume of 0.3 ml administered intraperitoneally, substantially augmented the interferon production to endotoxin over that in the controls, and the production was twice as great as the response to D4 alone. The response lasted several days and was hypothesized to be due to transient effects on splenic macrophages (laden with oil droplets), with decreased endotoxin clearance (R. S. Lake and M. F. Radonovich, "Action of Polydimethylsiloxanes on the Reticuloendothelial System of Mice: Basic Cellular Interactions and Structure-Activity Relationships," Dow Corning Corporation Research Department Report No. 5409, 1975). This study reported a dramatic adjuvant action as well as local cellular response to various silicones.

Direct responses of lymphocytes to silicone were not demonstrable by lymphocyte transformation,[64] but delayed-type hypersensitivity to PDMS fluid incubated with syngeneic pooled guinea pig serum (presumed silicone-protein complexes formed) was shown in inbred guinea pigs inoculated intraperitoneally with the silicone-serum plus complete Freund's adjuvant (CFA) before intradermal challenge.[65] Challenges with saline solution, serum alone, and silicone alone did not produce notable responses. Histologic examination revealed

a moderate to pronounced lymphocytic infiltrate only at the silicone-serum site and a positive response to purified-protein derivative testing at the control site. The results suggest that silicone-protein complexes are immunogenic. The ability of silicone gel to act as an adjuvant in a delayed-type hypersensitivity system was examined recently by inoculating gel with bovine serum albumin (BSA), saline solution and BSA, or CFA and BSA. Subsequent BSA intradermal challenge showed that silicone gel produced a cellular response to BSA equivalent to that of CFA.[66]

Another recent study examined the polyclonal human T-cell activation that resulted from incubating T cells with inorganic silicate (not silicone). The results suggested that silicate may act as a superantigen. The suggestion was made that this may play a role in scleroderma associated with occupational silica dust exposure.[67]

Humoral Immune Response

Silicone gel and amorphous silica have been shown in studies of animals to have adjuvant effects on the humoral immune response, and the presence of silicone-gel implants in humans has been associated with a variety of autoantibodies and antisilicone antibodies. The earliest study on humoral adjuvancy of medical-grade PDMS was done by Dow Corning in an unpublished report in 1974 (W. F. Boley and R. R. LeVier, "Immunological Enhancing Activity of Organosilicon Compounds and Non-Functional Fluids," Dow Corning File No. 1063-19 [report reference 63]). An adjuvant is a substance that enhances the immune response to an antigen. Adjuvants have not been known to cause disease in humans; rather, they have been used to increase antibody responses to various antigens in immunizations. Some adjuvants, however, particularly CFA and pristane, can produce notable disease, including autoimmunity, in animals. Dow Corning compared the ability of various silicon-containing compounds to stimulate anti-BSA antibody responses in guinea pigs immunized with BSA-saline solution or BSA-organosilicone compounds; CFA was the standard positive control. DC-360, or medical-grade silicone fluid used for administration, caused a 5.0 $\log_2$ increase in titer, compared with 1.3 for saline solution and 8.1 for CFA. Not all the silicone fluids exhibited adjuvancy using this specific assay.

The ability of silicone gel from a mammary implant mixed in a 1:1 ratio with DC-360 fluid to enhance the antibody response to BSA in rats was tested in 1993.[68] DC-360 fluid alone enhanced the antibody response only slightly compared with saline solution, but the response to the gel-fluid mixture was as great as that to the CFA. Dow Corning, in another internal report, repeated this research and came to similar conclusions—the gel potentiated the immune response considerably, whereas the DC-360 fluid response was only marginally notable, if at all (P. C. Klykken, T. W. Galbraith, M. R. Woolhiser, et al: "A Humoral Adjuvancy Study of Dow Corning Silicone Fluids Alone [360 fluid, 20cs; 7-2317, 1000cs] and Dow Corning 360 Fluid, 20cs, Mixed With Dow Corning Mammary Gel [Q7-2159a] or McGhan Mammary Gel in the Rat," Dow Corning Corporation Report 1993-10000-37981, 1993). These findings appear to complement the histologic reports that the higher-molecular-weight silicone gel produces more inflammation than the fluids.[16]

Studies on the adjuvancy of crystalline and amorphous silica suggest that effects on macrophages, which are the target of cytotoxicity by crystalline silica,[51,52] are primarily responsible. Crystalline silica was able in one system to stimulate antibody production to a T cell-dependent antigen, but not a T cell-independent antigen.[69] Another study suggested that nonspecific stimulation and expansion of the reticuloendothelial system were responsible for adjuvancy to crystalline silica.[70] Amorphous silica treated with various antigens was able to substantially enhance antibody response to the antigens except for BSA.[71] Patients with silicosis have had high titers of anticollagen type I antibodies and elevated levels of immunoglobulins—perhaps reflecting nonspecific B- and T-cell activation due to silica, postulated, as noted earlier, to be a superantigen[67]—and other autoantibodies including antinuclear antibodies (ANAs) and rheumatoid factors. It is not known whether the anticollagen autoantibodies are pathogenic or merely reflect the adjuvancy action of silica on a self-protein found in high quantities in the lungs of patients with silicosis.[72]

In our own studies, we looked at the anticollagen antibodies in women with silicone-gel breast implants and found that 26% of patients were positive for antibodies (>3 standard deviations above the enzyme-linked immunosorbent assay mean optical density of normal controls) against either native or denatured type I collagen. Only 2% of normal women had such autoantibodies. We hypothesized that if silicone induces an autoimmune response, reactivity would be expected against components of the peri-implant milieu, such as type I collagen.[73] We also examined reactivity to type II collagen; 20% of patients had antibodies against either native or denatured type II collagen. Western immunoblotting has subsequently been done on an expanded series of patients with anticollagen antibodies, with the results showing that the epitopes involved are different from those seen in the autoimmune diseases systemic lupus erythematosus and rheumatoid arthritis. Thus, it does not appear that these patients are in a prodromal phase of either of these autoimmune diseases, which some have associated with silicone implants.[74] Antibody responses against connective tissue proteins were also examined in women with implants. Results suggest that some patients produce antibodies against matrix molecules that have been altered from native conformation due to interaction with silicone, thus rendering them possibly more immunogenic.[75]

It also appears that antibodies can develop specifically against the silicone polymer itself, not just against associated connective tissue proteins. Two patients with

inflammatory reactions to silicone ventriculoperitoneal shunts exhibited immunoglobulin (Ig) G binding to silicone tubing in vitro.[76] A large study in women with implants showed substantial levels of IgG by enzyme-linked immunosorbent assay compared with normal controls, especially those women with ruptured implants. Most control patients did have background antisilicone antibodies.[77]

A higher-than-expected incidence of antinuclear antibodies was recently reported in women with implants.[78] Women with implants who were asymptomatic had an 18% incidence of positivity for ANAs (titers of at least 1:256) compared with 0% in the controls. Of women with various symptoms, but without a defined autoimmune disease, 26% were also positive for ANAs. In a series of patients with silicone-gel implants, 11 with autoimmune diseases and 13 with complaints such as myalgias or fatigue, the patients with autoimmune diseases had positive ANA tests, as expected (except one) but, in addition, 7 of 13 of the others were positive for ANAs with several bands of unknown specificity on immunoblotting.[79] The importance of antibodies to silicone or connective tissue components as they relate to possible disease is unknown at this time, but it is an issue of concern.

Discussion

Although no prospective epidemiologic studies that prove a relationship between silicone-gel implants and systemic disease have been done, two retrospective studies were recently published that could not establish a link, but lacked sufficient power to be considered definitive.[80,81] One was done in Sydney, Australia, and looked specifically at scleroderma; 4 of 251 women with scleroderma had implants, and 5 of 289 controls had implants.[80] At 90% power, this study has a minimum detectable relative risk of 5.3, and yet, with a disease like scleroderma, even a relative risk of 2.0 would be considered of great importance and could have been missed (S. H. Swan, PhD, School of Public Health, University of California, Berkeley, written communication, fall, 1994). Another study looked at all major connective tissue diseases, including, for unclear reasons, ankylosing spondylitis, which affected 3 women in the control group.[81] The minimum detectable relative risk for scleroderma based on the incidence in this study was 19.2 (with 90% power) (S. H. Swan, PhD).

It is possible that we will never be able to prove that a particular connective tissue disease, such as scleroderma, is associated with implants because of its overall rarity. However, researchers cannot assume that the patients with scleroderma reported to date in the literature are the only scleroderma patients with implants. In our own experience, we have examined eight patients with progressive systemic sclerosis who have not been reported in the literature. It is therefore misleading to take the number reported to date and divide it into 1 to 2.2 million—the putative number of women in the United States and Canada who have had implants in the past 30 years—to obtain a prevalence rate.[82] In addition, the denominator may be highly inaccurate because it is based on the number of implants sold and not on the actual number of women with implants. For example, in a series of 70 patients with implants in our clinic, more than 200 actual breast implants have been placed—many women required two or more surgical procedures to correct problems of capsular contracture or rupture. Also, the latency period for a disease such as scleroderma could be as long as 30 years if parallels can be drawn with scleroderma due to occupational silica exposure. Interested readers are referred to two recent publications that review the clinical reports of connective tissue disorders in patients with implants.[82,83]

It can be seen by the studies reviewed here that silicones are neither biologically nor chemically inert and that there is clinical and theoretical reason for concern. Patients may be exposed to implant constituents through gel bleeding, rupture, and biodegradation. The clinical importance of the adjuvant properties of many of the implant components is unknown. Prospective epidemiologic work and further studies that correlate the bioreactivity of silicone and its degradation products with clinical findings are anticipated. In the meantime, we do not routinely recommend that asymptomatic women who currently have intact silicone gel-filled implants undergo explantation. If a woman has an autoimmune disease, removal may be prudent, but the risks of a surgical procedure in each case must be individually clarified and balanced against the uncertain benefits of explantations, which could include psychological effects, the alleviation of local complications, or possible amelioration of the autoimmune disease process.

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* * *

Launching

She watches him launch it.

Petey, with his skipper
cap, his new toy boat,
a longed-for gift, adjusts
the sails, angles the rudder
till they're just right

for a light breeze. *Cast off!*
When the boat wallows, tips,
sails drenched with silver
dragging it under,
he's running, her son,

to the other side, shouting,
I'll bring you in.
What she, a grown woman,
a mother, couldn't do,
somehow bring her in

or get over to where
her lilac-blue girl
floats in a limbo
like this pool, shallow,
in some lonely marsh

down-hill from heaven.
Lilac-blue. She saw her.
Surfacing from twilight
sleep to rage and great
confusion. Sister Paul

hissing, *You said*
abort, no heartbeat,
Sister Luke pleading, *Please,*
let's baptize it,
while she's thinking, *Breathe,*

breathe in deep
to the baby who flops
in the doctor's hand, who mews
in air when she's slapped,
whose ribs scarcely move,

ribs that luffed like sails
when light air lapses
and wave wash stills
and the outbound ship's
adrift.

J. C. Todd©
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